INDOOR AIR QUALITY ASSESSMENT

City Hall Annex/CATA Building
3 Pond Road
Gloucester, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Center for Environmental Health
Emergency Response/Indoor Air Quality Program
March 2006

Background/Introduction

At the request of Jack Vondras, Director of the Gloucester Health Department (GHD), the Massachusetts Department of Public Health (MDPH), Center for Environmental Health (CEH), provided assistance and consultation regarding indoor air quality concerns at the Gloucester City Hall Annex (GCHA) located at the Cape Ann Transportation Authority (CATA) building at 3 Pond Road, Gloucester, Massachusetts. The request was prompted by general indoor air quality concerns and potential exposure to vehicle exhaust emissions.

On February 2, 2006, a visit to conduct an indoor air quality assessment at the GCHA was made by Cory Holmes, an Environmental Analyst in CEH's Emergency Response/Indoor Air Quality (ER/IAQ) Program. Mr. Holmes was accompanied by Chris Sergeant and Tom Corcoran, GHD; and by Tim Canillas, Steve Hoffmann and Rich Ingles of TJ Canillas & Hoffmann HVAC Service. Mr. Vondras was also present for portions of the assessment.

The building is a two-story, brick and steel building constructed in the mid- to late-1980s originally used as a screen printing shop. The building is owned and operated by the CATA, which occupies the first floor that includes a maintenance facility/garage in the eastern half of the floor. The GCHA occupies the second floor of the building and houses office space for five city departments: building, community development, public health, engineering and information technology. The GCHA has occupied the second floor space since January of 2006. The space underwent minor interior renovations prior to occupancy. Windows are openable in selected areas along the north side of the building.

Methods

Tests for carbon dioxide, carbon monoxide, temperature and relative humidity were conducted with the TSI, Q-Trak, IAQ Monitor, Model 8551. Moisture content of water damaged ceiling tiles was measured with a Delmhorst, BD-2000 Model, Moisture Detector equipped with a Delmhorst Standard Probe. CEH staff also performed visual inspection of building materials for water damage and/or microbial growth.

Results

The GCHA has an employee population of approximately 45 and can be visited by up to 40 individuals daily. The tests were taken during normal operations. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were below 800 parts per million (ppm) in all areas surveyed, indicating adequate air exchange. The heating, ventilating and air conditioning (HVAC) system consists of rooftop air handling units (AHUs) (Picture 1) equipped with high efficiency pleated air filters (Picture 2). Conditioned outside air is provided through ducted ceiling vents (Picture 3). Air is drawn into the ceiling plenum via spaces around lighting fixtures and returned to the AHUs by return grates located in the ceiling tile system (Pictures 4). This system was operating throughout the building during the assessment; however, missing/damaged ceiling tiles were observed in a few areas (Pictures 5 and 6). Ceiling tile systems must be intact to maintain the integrity of the ceiling plenum to provide exhaust ventilation.

Thermostats that control the HVAC system have fan settings of “on” and “automatic”. Thermostats were set to the fan “on” setting providing continuous airflow, which is recommended by the MDPH. The “automatic” setting on the thermostat activates the HVAC system at a preset temperature. Once the preset temperature is reached, the HVAC system is deactivated.

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of occupancy. In order to have proper ventilation with a mechanical ventilation system, the systems must be balanced subsequent to installation to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). System balancing at the GCHA is currently on-going.

The Massachusetts Building Code requires that each room have a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or openable windows (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The MDPH uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please see Appendix A.

Temperature readings ranged from 68^{o} F to 75^{o} F, with all but two areas surveyed during the assessment within the MDPH recommended comfort guidelines. The MDPH recommends that indoor air temperatures be maintained in a range of 70^{o} F to 78^{o} F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. During the visit, CEH staff stressed the importance of GCHA staff communication with their HVAC vendor regarding airflow and thermal comfort during final balancing of the system.

The relative humidity measurements in the building ranged from 25 to 32 percent, which were below the MDPH recommended comfort range in all areas on the day of the assessment. The MDPH recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

A few areas had water damaged ceiling tiles, most notably in the elevator lobby (Picture 7). Identification and elimination of water moistening building materials is necessary to control mold growth. In order for building materials to support mold growth, a source of water exposure is necessary. Occupants reported that ceiling tiles were damaged as a result of roof leaks that reportedly have since been repaired. Water damaged ceiling tiles can provide a source for mold growth and should be replaced after a leak is discovered and repaired. CEH staff removed ceiling tiles in a number of areas to examine conditions above the ceiling plenum. All areas appeared dry, and no visible mold growth and/or associated odors were observed/detected on the day of the assessment. In addition, CEH staff conducted moisture testing of water damaged ceiling tiles. Materials with increased moisture content *over normal* concentrations may indicate the possible presence of mold growth. All water damaged ceiling tiles tested were found to have low (i.e., normal) moisture content (Table 1) at the time of the assessment.

A water cooler was located over carpeting (Picture 8). Water spillage or overflow of cooler catch basins can result in the wetting of the carpet. In addition, the cooler had residue/build-up in the reservoir. These reservoirs are designed to catch excess water during operation and should be emptied/cleaned regularly to prevent microbial and/or bacterial growth.

Plants were noted in several areas. Plants should be properly maintained and equipped with drip pans. Plants should be located away from ventilation sources to prevent aerosolization of dirt, pollen or mold. Plants should not be placed on porous materials, since water damage to porous materials may lead to microbial growth.

Other IAQ Evaluations

Some occupants expressed concern over the potential entrainment of exhaust emissions from the day to day vehicle operations of the CATA maintenance facility. The CATA maintenance facility is equipped with local exhaust ventilation that connects directly to the tailpipes of vehicles; vehicle exhaust is piped out to the roof through exhaust motors. Rooftop exhaust motors are ducted in a fashion that direct exhaust emissions *away* from the AHUs supplying air to GCHA office space (Picture 9).

Although no complaints of exhaust odors were reported on the day of the MDPH assessment, the potential for entrainment exists. A more likely source for entrainment of exhaust emissions is from vehicles idling along the north side of the building. The AHU for the engineering department is situated on the roof along the edge of the north side of the building, with air intakes facing the area where busses and other CATA vehicles park (Pictures 10 and 11). These air intakes can draw in odors from idling vehicles.

Exposure to carbon monoxide can produce immediate and acute health affects. Several air quality standards have been established to address carbon monoxide pollution and prevent symptoms from exposure to these substances. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide level over 30 ppm, taken 20 minutes after resurfacing within a rink, that operator must take actions to reduce carbon monoxide levels (MDPH, 1997).

ASHRAE has adopted the National Ambient Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from 6 criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2000). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State Building Code (SBBRS, 1997). According to the NAAQS established by the US EPA, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2000).

Carbon monoxide should not be present in a typical, indoor environment. If it *is* present, indoor carbon monoxide levels should be less than or equal to outdoor levels. For the GCHA, indoor carbon monoxide concentrations were non-detect or ND (Table 1). Carbon monoxide levels measured outside the building were also ND.

As a precaution GCHA employees have mounted a carbon monoxide monitor on an interior wall (Picture 12). According to the manufacturer's website, carbon monoxide alarms should be replaced every 5 years. Batteries should be monitored and replaced as needed to ensure proper working order (First Alert, 2006).

Building occupants reported dryness, respiratory and eye irritation. There are a number of inter-related issues that can contribute to this complaint. A possible source of irritants is the accumulation of dust on flat surfaces throughout the space. Dust can be irritating to the eyes, nose and respiratory tract. The large amount of flat surfaces provides a means for dusts, dirt and other potential respiratory irritants to accumulate and become airborne.

Lastly, holes were cut into walls in both the men's and women's restrooms, exposing fiberglass insulation (Picture 15). If work has been completed, these holes should be sealed. Fiberglass insulation can provide a source of skin, eye and respiratory irritation.

Conclusions/Recommendations

In view of the findings at the time of the visit, the following recommendations are made:

1. Continue working with HVAC vendor to balance the ventilation system. Ventilation industrial standards recommend that mechanical ventilation systems be balanced every five years (SMACNA, 1994).
2. Replace missing/damaged tiles to maintain integrity of the ceiling exhaust/return plenum.
3. Consider the following steps if vehicle exhaust entrainment becomes a persistent problem in the engineering area:
    - Install charcoal-activated filters in rooftop AHUs to filter out or reduce vehicle exhaust odors.

- Relocate (or re-duct) the intake for the engineering department AHU to the opposite side, away from areas of heavy vehicle traffic (idling) if complaints persist.

4. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (e.g., throat and sinus irritations).
5. Report any water leaks as they occur to building management for repair. Replace water damaged ceiling tiles and examine the areas above and behind these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial as needed.
6. Ensure plants have drip pans. Examine drip pans periodically for mold growth and disinfect with an appropriate antimicrobial where necessary.
7. Relocate or place tile or rubber matting underneath water coolers in carpeted areas. Clean and disinfect reservoirs as needed to prevent microbial growth.
8. Remove grates and clean supply/return vents periodically of accumulated dust.
9. Consider cleaning carpeting annually or semi-annually in soiled high traffic areas as per the recommendations of the Institute of Inspection, Cleaning and Restoration

Certification (IICRC). Copies of the IICRC fact sheet can be downloaded at: http://www.cleancareseminars.com/carpet_cleaning_faq4.htm (IICRC, 2005)

10. Seal holes in men's and women's restrooms to prevent exposure to fiberglass insulation.

11. Replace carbon monoxide detectors every 5 years, replace batteries and test to ensure proper working order as per the manufacture's recommendations.

12. Refer to resource manuals and other related indoor air quality documents for further building-wide evaluations and advice on maintaining public buildings. Copies of these materials are located on the MDPH website: http://mass.gov/dph/indoor_air.

References

ACGIH. 1989. Guidelines for the Assessment of Bioaerosols in the Indoor Environment. American Conference of Governmental Industrial Hygienists, Cincinnati, OH.

ASHRAE. 1989. Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigeration and Air Conditioning Engineers. ANSI/ASHRAE 62-1989

BOCA. 1993. The BOCA National Mechanical Code/1993. 8th ed. Building Officials and Code Administrators International, Inc., Country Club Hill, IL. Section M-308.1.1.

First Alert. 2006 Carbon Monoxide Alarm FAQs. http://www.firstalert.com/CarbonMonoxideAlarmsFAQs.aspx [accessed: February 17, 2006]

IICRC. 2005. Carpet Cleaning FAQ 4 Institute of Inspection, Cleaning and Restoration Certification. Institute of Inspection Cleaning and Restoration, Vancouver, WA.

MDPH. 1997. Requirements to Maintain Air Quality in Indoor Skating Rinks (State Sanitary Code, Chapter XI). 105 CMR 675.000. Massachusetts Department of Public Health, Boston, MA.

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

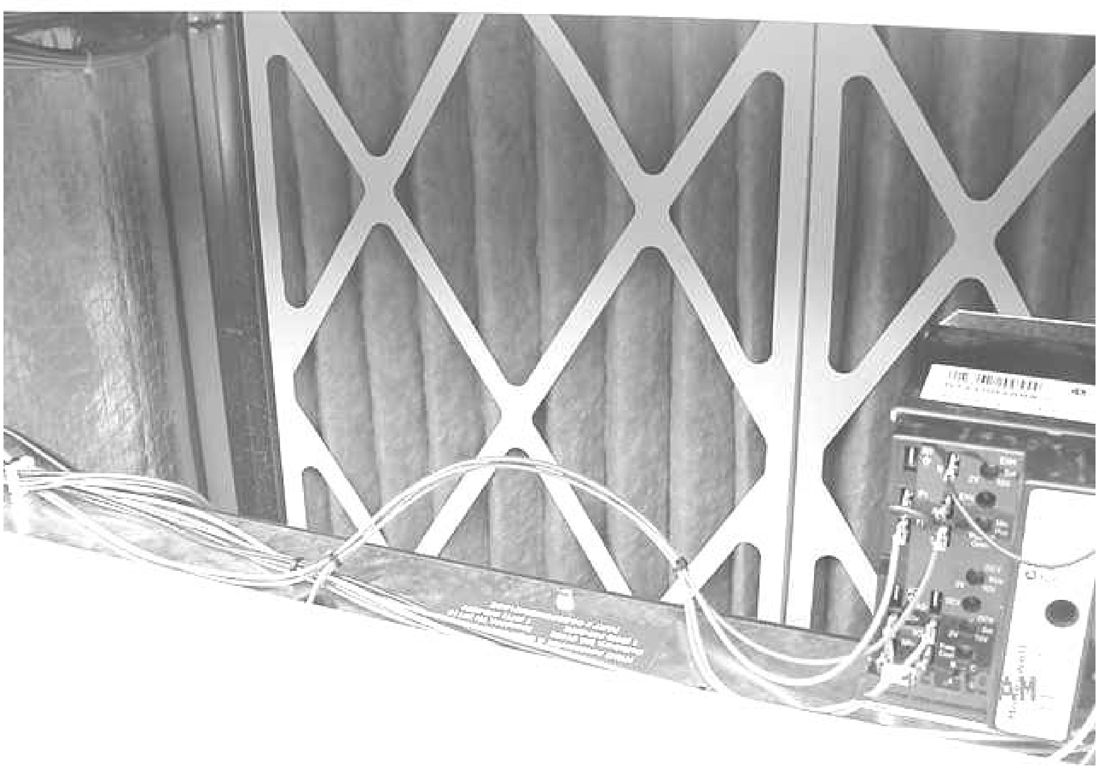
SMACNA. 1994. HVAC Systems Commissioning Manual. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly, VA.

US EPA. 2000. National Ambient Air Quality Standards (NAAQS). US Environmental Protection Agency, Office of Air Quality Planning and Standards, Washington, DC. http://www.epa.gov/air/criteria.html.

Picture 1

Rooftop Air Handling Units

Picture 2



High Efficiency Pleated Air Filters in AHUs

Picture 3

Multi-Directional Supply Air Diffuser

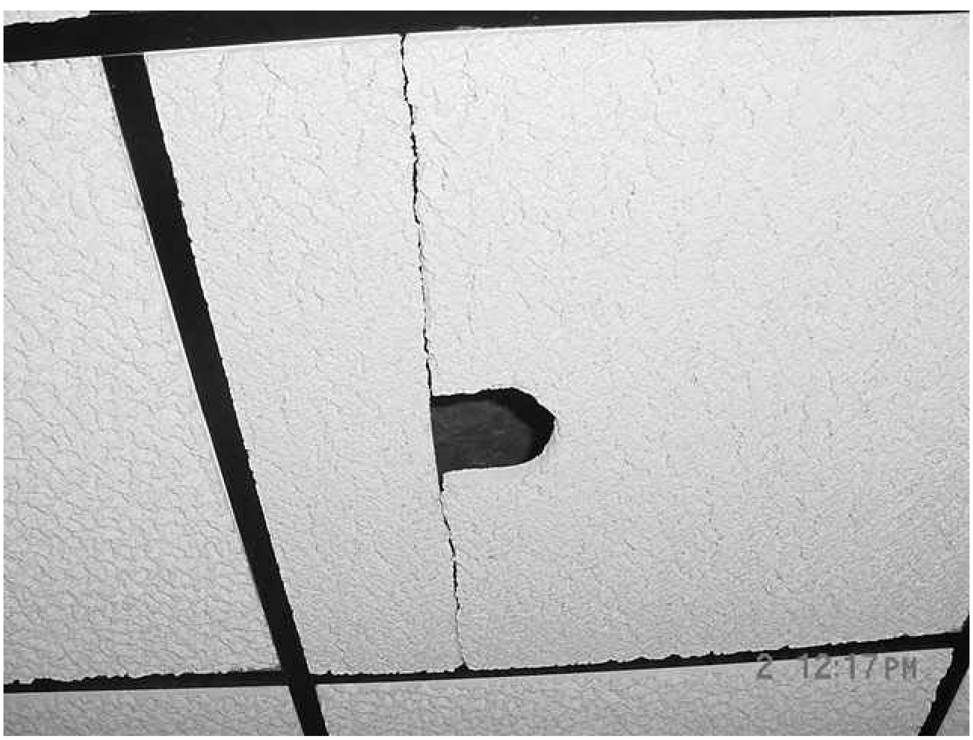
Picture 4

Ceiling-Mounted Return Grate

Picture 5

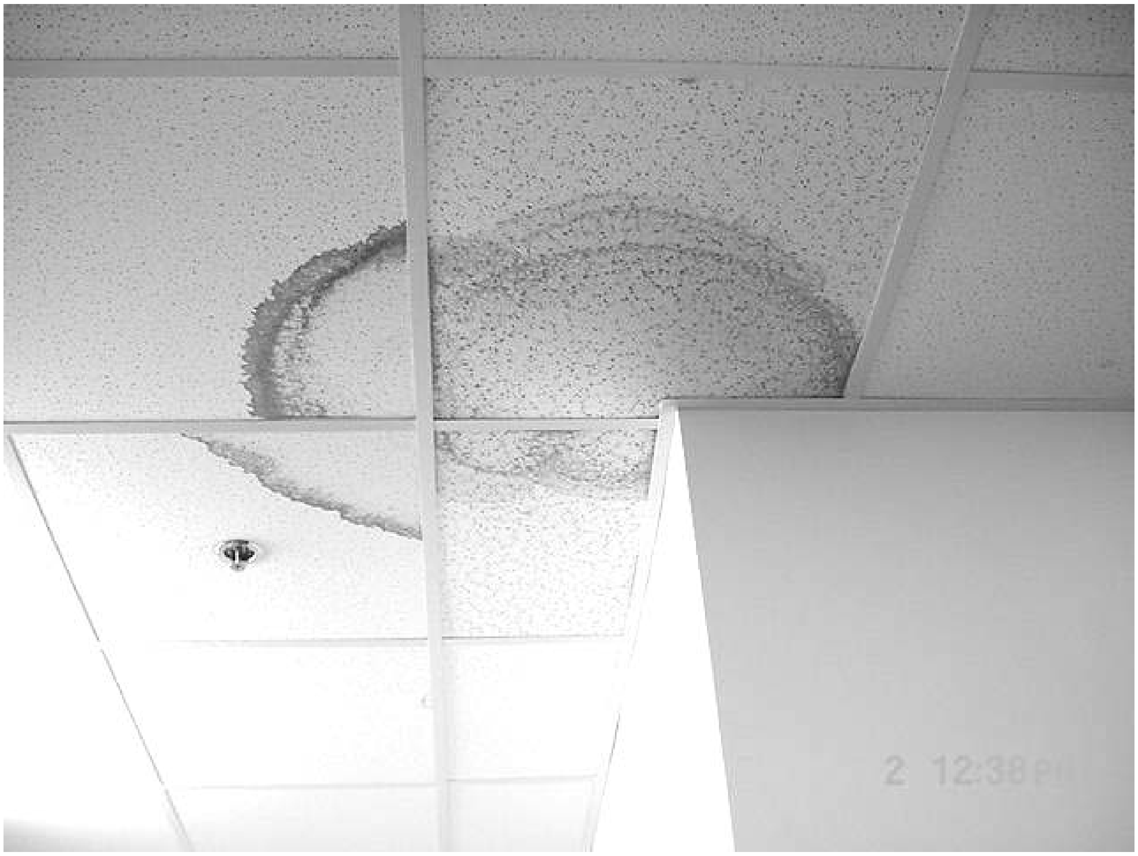
Missing Ceiling Tile

Picture 6



Hole in Ceiling Tile

Picture 7



Water Damaged Ceiling Tiles in Elevator Lobby

Picture 8

Water Cooler on Carpeting

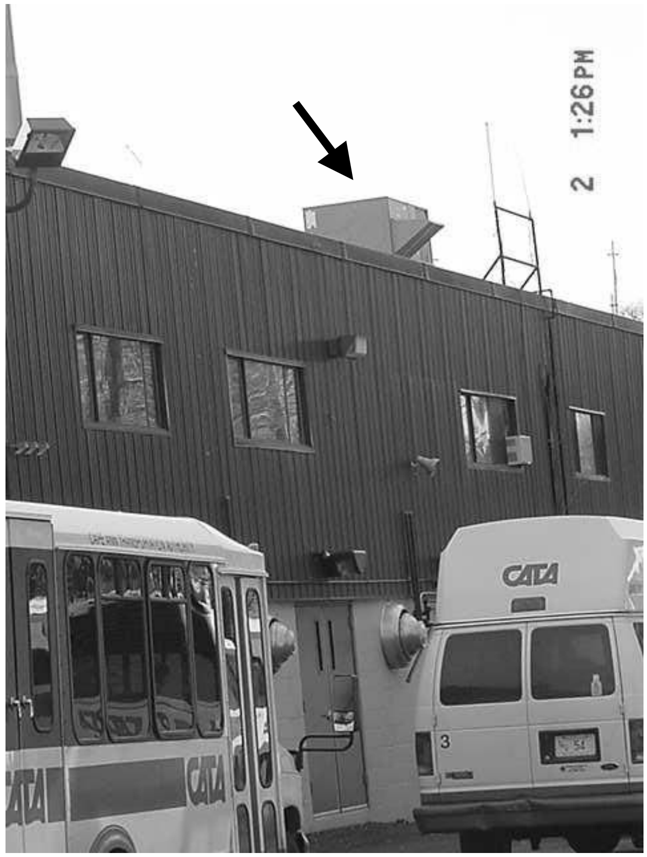
Picture 9

Local Exhaust Motor on Roof of CATA Building Directing Exhaust Emissions *Away* From GTHA AHUs

Picture 10

Orientation of Engineering Dept. Air Intake to CATA Vehicles Parked along the North Side of Building

Picture 11

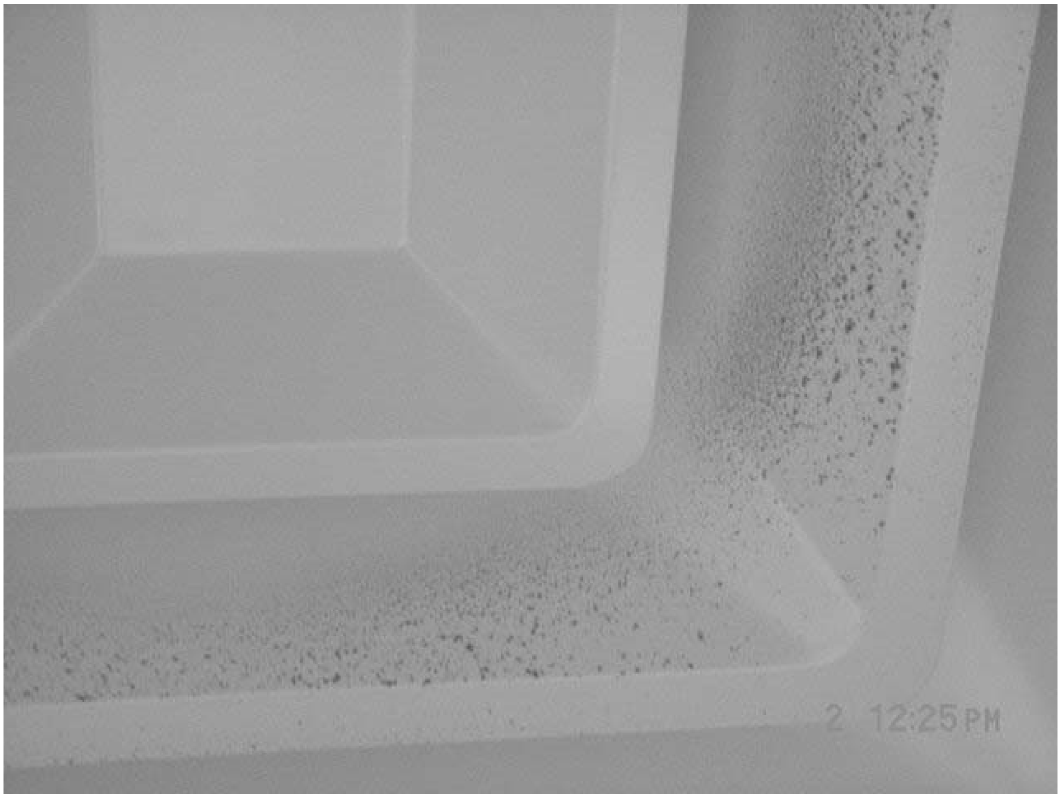


Orientation of Engineering Dept. Air Intake to CATA Vehicles Parked along the North Side of Building

Picture 12

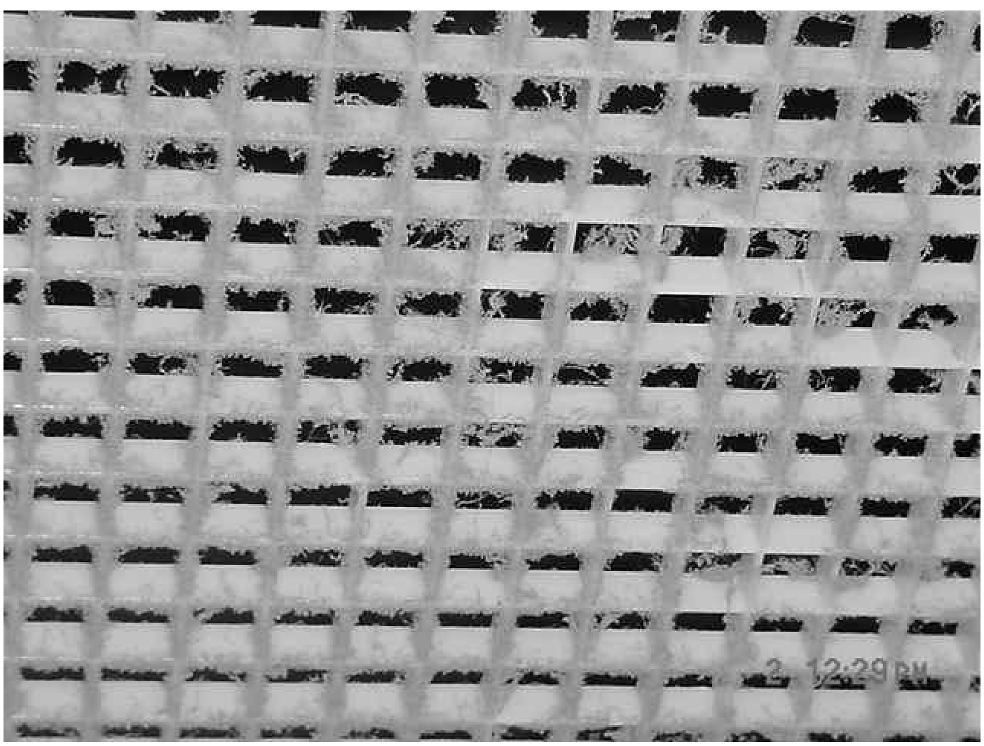
Wall-Mounted Carbon Monoxide Detector

Picture 13



Dust Accumulation on Supply Louvers

Picture 14



Dust Accumulation on Return Grate

Picture 15

Hole in Restroom Wall Exposing Fiberglass Insulation

TABLE 1

Indoor Air Test Results – Gloucester, City Hall Annex February, 2, 2006

Location	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	Temp °(F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
							Supply	Exhaust	
Background	386	ND	42	36					Mild, mostly cloudy, SW winds 5-10 mph
Vondras	730	ND	68	32	1	N	Y	N	Door undercut
Room 10	688	ND	70	30	0	N	Y	N	
Corcoran	658	ND	70	30	0	N	Y	Y	
Oliver/McMahon	654	ND	70	29	1	N	Y	Y	
Sargent/Nicastro	654	ND	70	30	2	N	Y	Y	
O'Hanley	679	ND	70	29	1	N	Y	Y	
Room 9	766	ND	75	28	2	N	Y	N	
Engineering Reception	799	ND	71	29	5	N	Y	Y	
24	761	ND	71	28	0	Y	Y	Y	

*** ppm = parts per million parts of air**

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 1

Indoor Air Test Results – Gloucester, City Hall Annex   February, 2, 2006

Location	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	Temp °(F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
							Supply	Exhaust	
23	720	ND	72	28	1	Y	Y	Y	1 missing ceiling tile, plant
25	727	ND	68	27	0	N	Y	N	Cold complaints, AC, 1 water damaged ceiling tile-sprinkler
31	695	ND	71	27	0	N	Y	N	
13 C/B	591	ND	72	26	1	N	Y	Y	1 water damaged ceiling tile, 1 damaged ceiling tile
Room 8	656	ND	72	27	2	N	Y	N	Door open-undercut, plants, humidifier
Room 7	592	ND	72	26	1	N	Y	N	Plants, door undercut
13 D	586	ND	72	26	0	N	Y	N	Carbon monoxide monitor on wall
Room 6	604	ND	71	26	0	N	Y	N	Door undercut
Room 14	642	ND	71	26	1	N	Y	N	Complaints of stuffiness/dryness, door undercut, dusty vents
Room 5	627	ND	71	26	0	N	Y	N	Plants

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							Supply	Exhaust	
Room 4	565	ND	71	26	0	N	Y	Y	Plants
Community Development Reception	585	ND	71	26	1	N	Y	Y	Plants
Room 2	600	ND	73	26	1	N	Y	Y	Missing ceiling tile, dusty vents
Room 3	589	ND	74	25	3	N	Y	Y	Plants
Elevator Lobby	644	ND	73	25	0	N	Y	Y	8 water damaged ceiling tiles-low (normal) moisture content, no visible mold/odors above CTs
Info Tech Dept	606	ND	73	25	2	N	Y	Y	
Room 16	642	ND	72	25	1	N	Y	N	Door open/undercut
Men's Room	633	ND	72	26	0	N	N	Y	Hole in wall-fiberglass insulation
Women's Room	675	ND	72	26	0	N	N	Y	Hole in wall-fiberglass insulation

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